



TDAQ WBS 6.6



Introduction

- ❖ TDAQ WBS 6.6 (was 5.6) less concrete by its nature and information mainly from the Director's Review in 2014
- ❖ Some significant changes proposed for TDAQ Phase-II upgrade since Lol, and various scenarios being exercised in re-costing process
- ❖ Changes foreseen and to be briefly discussed



TDAQ Phase-II Upgrade

❖ Motivation

- Low single lepton thresholds (~ 20 GeV) needed to fully exploit the HL-LHC physics program
- Hadronic tau decays important for Higgs and new physics studies
- Fully hadronic triggers needed for missing energy, multijets, etc for SUSY and DM studies

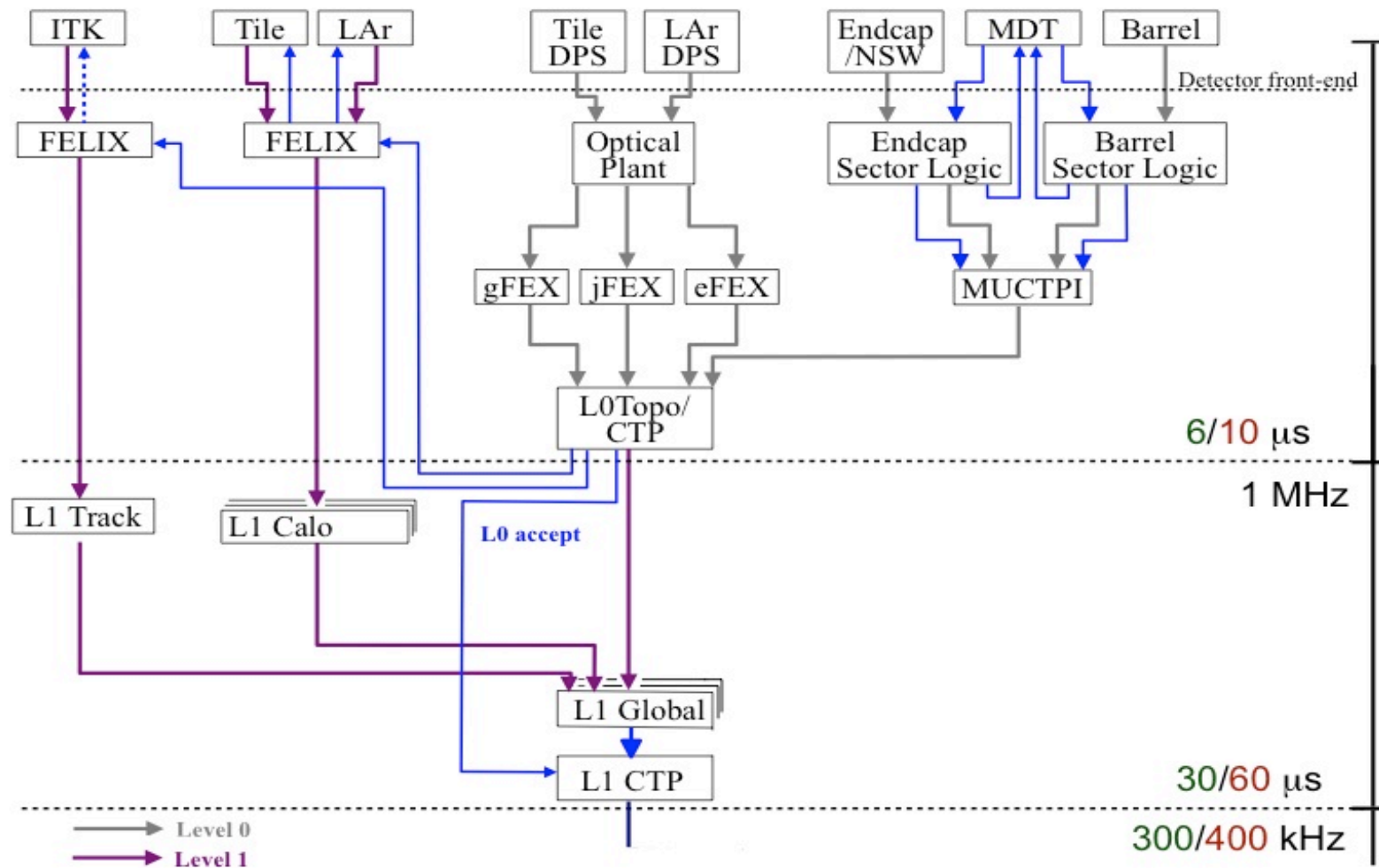
❖ Spec highlights (evolving since Lol)

- Split L0/L1 architecture
- Rate and latency (L0: 1 MHz, 6 μ s; L1: 300-400 kHz, 30 μ s)
- Phase-I L1CALO to be Phase-II L0CALO
- L1Track to be FTK-like and RoI based
- FELIX as new detector readout

❖ Timeline

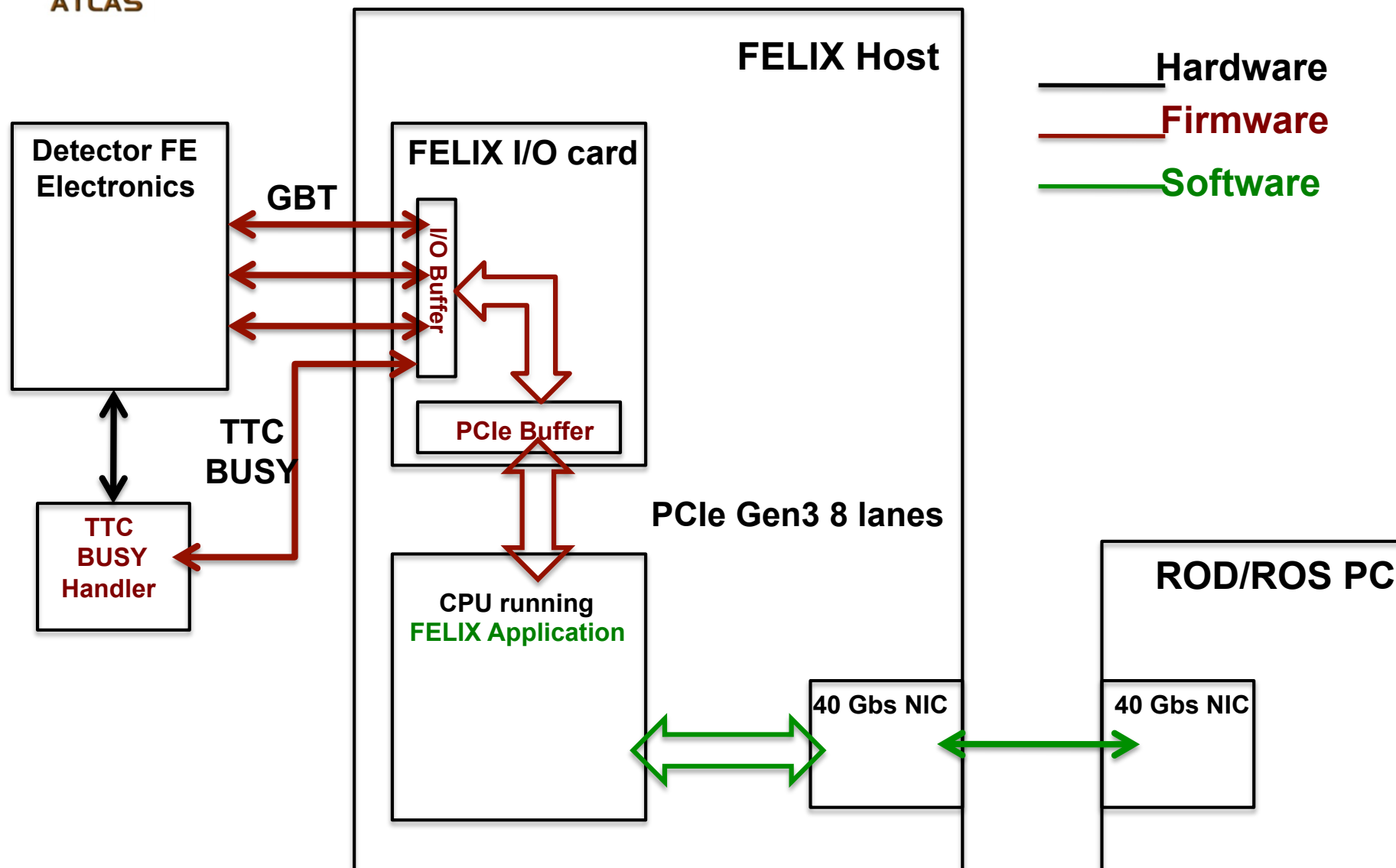
- IDR in Q1 2016
- TDR in Q4 2017

Phase-II Architecture





FELIX as Detector Readout





WBS 6.6

WBS	Description	Institutes
6.6.1	Track Trigger	
6.6.1.1	L1Track	ANL, Indiana, Penn, SLAC
6.6.1.2	FTK upgrade	Chicago, NIU, UIUC
6.6.2	Calorimeter Trigger	
6.6.2.1	LOCALO	Chicago, Indiana, MSU
6.6.2.2	L1CALO	BNL, Chicago, Indiana, Louisiana, MSU, Oregon, Penn, Pittsburgh
6.6.3	Readout/DAQ	
6.6.3.1	FELIX	ANL, BNL, Oregon
6.6.3.2	ITK Readout	SLAC



6.6.1 Track Trigger

- ❖ L0 rate reduction by a factor of 5 (L1Track) and HLT full event tracking at up to 100 kHz (FTK++)
- ❖ US interests expressed (sample)
 - L1Track
 - Architecture design, performance, I/O hardware design, Regional Readout Request (R3) collection and distribution, data formatter, AM carrier board, track finding, L1Calo track matching
 - FTK upgrade
 - Hit organization, transmission, track fitting (ATCA based system, etc)
- ❖ US contribution level based on the FTK project
- ❖ US institutes including mainly the FTK institutes



6.6.2 Calorimeter Trigger

- ❖ Improving L0CALO and using full-detector granularity in L1CALO
- ❖ US interests expressed (sample)
 - L1CALO
 - Full granularity LAr processing using System-on-Chip (SoC), FEX for boosted jet systems, FEX firmware, HT and missing HT reconstruction, firmware for L1 processors for tau, L1Track Combination
- ❖ US contribution level based on Phase-I L1CALO upgrade(HUB, FOX, gFEX)
- ❖ US institutes including mainly L1CALO institutes



6.6.3 Readout/DAQ

- ❖ New detector readout system (already being deployed in Phase-I)
- ❖ US interests expressed (sample)
 - FELIX
 - Firmware similar to Phase-I contributions and possible hardware
 - ITK ROD
 - Data formatter – in combination with L1Track and FTK Upgrade, generic ROD hardware, firmware, software
- ❖ US contribution level based on FELIX project
- ❖ US institutes including mainly FELIX institutes



Cost Estimation

	US Labor (FTE)	US Core (k \$)	US Total (k\$)	ATLAS Core (Ayk\$)
L1Track	6.1	2,656.380	4,064.202	4,179.728
FTK upgrade	5.5	2,390.742	3,657.782	3,761.755
L0/L1CALO	20.2	1,087.367	5,924.078	3,552.769
Readout/DAQ	7.5	803.209	2,303.209	2,612.330
Total	39.4	6,937.698	15,949.272	

- ❖ Exchange rate in Phase-I TDR
- ❖ Inflated to 2019 by 3% annually
- ❖ US Core contribution fraction (Track trigger ~52%, Calo trigger ~25%, readout ~25%)



Scoping

Draft Scoping steps for ATLAS Trigger/DAQ

	Upper	Medium	Low
L0 Rate	1 MHz	1 MHz	1 MHz
L1 Rate	400 KHz	200 KHz	200 KHz
EF Rate	10 KHz	5 KHz	5 KHz
Trk η Coverage	4.0	3.2	2.5
L1 Track Params	$p_T > 4$ GeV	$p_T > 4$ GeV	$p_T > 8$ GeV
FTK++ Params	$p_T > 1$ GeV 100 KHz	$p_T > 1$ GeV 50 KHz	$p_T > 2$ GeV 50 KHz
Muon BI RPC	✓		
MDT in L0	BI & BM & BO	BM & BO	None
Muon with TileCal			✓



ATLAS Core Costs for Scoping

		LOI	Upper	Middle	Low
L0	Level-0 Calorimeter	0.20	0.63	0.63	0.39
	Level-0 Muon Barrel	1.97	1.18	1.15	0.79
	Level-0 Muon Endcap	0.6+0.9	1.55	1.55	0.60
	Level-0 Central	1.05	1.02	1.02	1.02
L1	Level-1 Track	4.00	7.29	6.19	4.73
	Level-1 Global	3.20	3.09	3.09	3.09
	Level-1 Central	1.35+1.25	1.90	1.90	1.90
HLT	FTK++		13.40	8.38	3.55
	Event Filter	3.94	7.20	5.84	5.84
DAQ	Detector Readout	2.50	8.70	6.80	6.80
	Data Flow	2.80	1.47	0.93	0.93
Total		24.2	47.42	37.48	29.63
US percentage based on current estimate (\$6,937k)		28.8%	14.7%	18.6%	23.6%



Comments on TDAQ Software

- ❖ TDAQ software not part of construction project but a critical component to ensure the project success and operation afterwards
- ❖ Large contributions to TDAQ software in operation from US, and some areas benefitting both Phase-I and Phase-I upgrade
- ❖ Prepare a WBS (though not costing) with information on current US contributions on TDAQ software potentially benefitting Phase-II upgrade, and the contributions needed to Phase-II projects in order to maintain the similar level of impact



Next Steps

- ❖ Work with TDAQ management and project coordinators
 - To incorporate the changes introduced into the projects US interested in
 - Overall scale change due to the higher trigger rate
 - Muon trigger implication
 - Commonality and difference between L1Track and FTK++
 - L1CALO hardware and FTK++ hardware
 - WBS boundary of Detector readout (FLEIX etc)
 - To identify the suitable deliverables for US institutes
 - US expertise and impact so scope adjustments (L1Global/L1Central?)
 - Modularization for different cost scopes
 - L0 Muon trigger participation (?)
- ❖ Develop the WBS structure (down to the level at which each item is associated with only one institute), e.g., at L5 or L6:
 - Board design
 - Control firmware
 - Algorithm firmware 1
 - Algorithm firmware N
- ❖ Discuss with all US TDAQ institutes to complete the WBS

